A HISTORY OF WATER
SERIES III, VOLUME 3

WATER AND FOOD

EDITED BY
TERJE TVEDT AND
TERJE OESTIGAARD

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Water and Food

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A History of Water

Series III

Volume 3: Water and Food
From Hunter-Gatherers to Global Production in Africa

Edited by

Terje Tvedt *and* **Terje Oestigaard**

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Approaches to African Food Production from a Water System Perspective

Terje Tvedt and Terje Oestigaard

FOOD AND AGRO-WATER VARIABILITY AND RELATIONS

This volume will show that food production in general, and Africa's history in particular, cannot be understood properly without locating them within particular water systems. From the early evolutionary history of mankind to the future global challenges of feeding 9 billion people, the relationship between water and food production is fundamental.[1] The developments of complex societies and civilizations were to a large extent based on the wealth generated by surplus agricultural production in natural or artificially irrigated land, and the revolutionary population growth during the last century was due to more efficient food production, which again – and this has been tended to be overlooked in many analyses of the Green revolution – was premised on radically more and different uses of water. Future pressure on water resources and water management in order to increase food production will thus most likely increase. Very few now share the widespread optimism of the early 1970s, when the world's population turned 4 billion and the then US Secretary of State, Henry Kissinger, proclaimed that 'no child will go to bed hungry within ten years'.[2] As development continues and the number of people increases, meeting the world's demand for food, and thus for water, will be one of the most important challenges for the world community in the twenty-first century.

The intimate connection between poverty and food and water is, of course, not a recent phenomenon. In the Old Testament, Genesis 41:30–32 tells the infamous story from Pharaonic Egypt:

> Seven years of great plenty will come throughout all the land of Egypt; but after them seven years of famine will arise, and all the plenty will be forgotten in the land of Egypt; and the famine will deplete the land. So the plenty will not be known in the land because of the famine following, for it *will be* very severe.

The seven successive rich years followed by seven years of famine should partly be read metaphorically, highlighting that even the richest and most fertile areas for agricultural production, generating immense wealth in good years, may suffer from food insecurity and famine in years when the life-giving rains or the annual floods fail or are insufficient, or if there is too much water at the wrong time for cultivation. This story in Genesis should also be seen as a story expressing the knowledge people at that time had of water in general and the hydrological cycles of the Nile in particular. They knew the connections between water and food and life and death, and they knew that the amount of water carried by the Nile was never the same, and periodically changed radically with dire consequences, but at that time they had no means to control this water. In a long-term perspective this Biblical prophecy can be seen as a commentary to the anxieties of what can be termed 'The Age of Water Insecurity'.[3] This is an era where uncertainty about the future waterscape – whether there will be more droughts or more floods or whether the sea will rise because the ice will melt – dominates, with immense consequences for food production.

The world population is predicted to grow from 6.9 billion in 2010 to 8.3 billion in 2030 and 9.1 billion in 2050, and food demand is predicted to increase by 60 per cent by 2050.[4] Currently, it is estimated that some 860 million people go hungry in the world despite the fact that globally there is enough food to feed everybody. Calculations suggest that in mere volume there will be enough food for 9 billion people in 2050. In Africa, the population is expected to increase from around 1 billion today to 2 billion in 2050. Economic growth and individual wealth result in shifting diets from predominantly starch-based to meat and dairy, which require more water. The production of 1 kg of beef may require five times more water than the production of 1 kg of grain. Hence, not only population growth but the rapid growth in the global middle class puts more pressure on water for food production. Still, it has been asserted that there is no food crisis, only a crisis of just and efficient distribution. We will argue that it is an issue of distribution, of market efficiency, but that regional and local deficiencies in food production cannot be reduced to social variables alone, due to extreme (and in the future unknown) differences in agro-water variability and food–water systems across the globe.

There is hardly any topic that has been discussed so widely, and for so long a time, as food production regimes and their consequences for societal development. Archaeologically, agriculture is the origin of civilization and the basis for economic development. Without surplus food production, stratified societies could only emerge to a limited degree. The whole chronological development of prehistory worldwide is based on agriculture. The Danish scholar, Christian Jürgensen Thomsen, was proposing the Three-Age system in 1836, classifying the past into Stone Age, Bronze Age and Iron Age. This was based on the raw material of the tools used and did not relate directly to the different modes of subsistence:

hunting and gathering or farming. In 1865, John Lubbock divided the Stone Age into two categories: an older Palaeolithic (Old Stone) period and a later Neolithic (New Stone) period.[5] The Neolithic period was characterized by agriculture and the origins of agriculture have been an ever-reoccurring theme in archaeology. Crucial in the debates on the origins of agriculture is the question of domestication of plants and animals and the relation to different degrees of sedentary practices using non-domesticated species.[6] The focus here will not be the raw materials of tools, or overall modes of subsistence practices, but different methods of food production and their shifting relationships to agro-water variabilities. We suggest that major periodizations of agricultural history can be based on shifts and differences in such agro-water relations.

Food production represents a form of adaptation to the local and regional characteristics of the physical and engineered waterscapes. Wheat and rice, goats and camels, fish and fowl – they all thrive in different waterscapes according to tolerance to drought and waterlogged soil, degrees of water salinity and stream velocity, and so on. Precipitation will in many areas be the ultimate source of water for food production, and therefore the seasonal variations of how water runs in the landscape and through agricultural lands – annual rains or floods, the absence or presence of which types of water at what time of the year, discharge curves of rain-fed rivers – are physical premises for food production. A nomad society in semi-arid regions or in deserts is structured differently from farming and fishing communities living in wetland areas. This difference is very easy to observe, but it is at the same time a clear illustration of a more complex and universal phenomenon: how can confluences between water and society structuring food and agricultural production be framed?

While agro-water relations tend to structure food-producing regimes, different food systems are also intrinsically interwoven into the social matrix of any society; political, economic, cultural and religious premises influence what is grown and how it is harvested, and also what is culturally accepted as food. Societal development in the past was not merely a matter of subsistence or surplus production for exchange or trade enabling elites: the very modes of production and types of food produced enabled distinctive development trajectories. Specific waterscapes that were often continuously modified over time, encouraged the creation of certain agricultural activities, cropping patterns, plot sizes, and crops' complementarity. These in turn influenced certain types of societies and food-production systems. All long-term agricultural history can therefore be fruitfully analysed in an agro-water variability perspective, since these relationships and interconnections have created and re-created the context for the farmers' choices and agency in fundamental ways.

Still, the more complex relation between water and food has not yet been explored in depth within a historical and comparative perspective. This volume aims to provide a modest input to this process. In order to

deepen our understanding of water and food systems, it focuses on forms of food production as both a livelihood strategy and an economic process, from an individual level to state organization and distributions within a country and beyond, and how they relate to and impact on each other.

WHY FOOD AND WATER IN AFRICA?

There are several reasons why Africa as a continent has been chosen as the focus of this volume on water and food. Not only did modern human evolutionary history start in Africa, but many agricultural innovations developed on the African continent in relation to the wider world.[7] Many of the most important general practices and processes regarding water and food systems can be studied in Africa: hunters and foragers in the past and the present, fisheries from small-scale to industrial scale, rain-fed agriculture and irrigation, nomadism and pastoralists, devastating droughts and floods, climate change adaptation and mitigation, local tenure systems and colonial governance, independence and adaptation to marked liberalism, and interactions and dependencies at various levels from individual households to states and the wider world.

While the focus is on Africa, the case studies will also have relevance to food and water relations in other parts of the world. Africa has a special contemporary relevance, due to the food-shortage problems faced by the continent and many of its countries. In the early 1960s, Africa was more or less food self-sufficient but since then food security has decreased, albeit with regional differences.[8] Hence, being concerned with reconstructing the history of food production in relation to water variability and availability, and its management, this book rests on two premises. On the one hand, historical analyses of interconnections between water and food regimes have an important value in themselves. On the other hand, Africa's current and future food challenges cannot be understood sufficiently without taking a historical perspective and making a comparative analysis of local and regional waterscapes and different water–society relations.

This volume will therefore employ a long historical perspective on the history of African food production, from hunter-gatherers 10,000 years ago to today's large-scale foreign investments in agriculture; from the rainforests to the deserts in some of the most extreme and different climates, and the varying environments and water availabilities in between these extremities, including the great lakes in the Interlacustrine region; from South Africa at the tip of the continent to the delta in Egypt and the Mediterranean Sea, and from Ethiopia in the East to Morocco in the West.

The understanding of Africa is caught up in a paradox: Africa is a rich continent when it comes to natural resources, and yet it is at the same time

the continent that still symbolizes and expresses poverty and food insecurity. In particular, areas of sub-Saharan Africa continue to face huge challenges with persistent hunger, and hunger is most widespread in rural areas. Farmers and smallholders account for about 65 per cent of Africa's labour force, but in the last decades there have also been significant changes in rural areas. Rural households have increasingly been involved in non-agricultural income earning businesses, like trade, handicrafts, fishing, forestry and other small-scale activities.[9] These shifts are important since they alter the food production regimes.

In theory, it is argued, there is more than enough water and food for Africa's own food production and it is even claimed that Africa has the potential to feed other parts of the world.[10] Africa's history of water and food thus points in two different directions: on the one hand, it has been plagued by chronic food insecurity and climate variability for millennia, but on the other hand, it has also given rise to major agricultural civilizations, including the ancient Egyptian and Nubian civilizations, and export of food beyond the continent. As this volume illustrates, the food insecurity in recent decades is not a new phenomenon and throughout history from early hunter-gatherers through major civilizations to colonialism to the present day, there have been varying degrees of food security while at the same time Africa's water and land have produced large surpluses and wealth, and in different periods and regimes enabled major exports of food out of the continent. Understanding water and food in Africa in an historic and comparative context may thus enable new insights into the evolution of food systems from the early humans to today's challenges in the global world.

FOOD IN A WATER SYSTEM PERSPECTIVE

This volume presents a number of case studies from African history together with methodological and theoretical arguments for analysing food production regimes using a water system approach. The term should for several reasons be contrasted with the 'ecological system' concept and the theories behind it. (A) The focus on water implies that the term 'ecological system' is considered too broadly, because it is empirically close to impossible to study the relationship between societies and ecological systems due to the fact that ecological systems are almost everything. (B) Since all ecosystems rely on water and all agricultural societies need to manage water, water is a universal factor in all food regimes and at the same time easier to 'follow' empirically and analytically, both when it comes to flora and fauna and in society. (C) The water system approach does not treat the whole social or physical world and their relations as a unity in varying degrees of (distorted) equilibrium. On the contrary, it is more

concerned with conflicts and paradoxes between elements in the waterscape and between the waterscape and society. (D) More specifically, a water system approach probes into the heart of the nature–culture dichotomy, since water does not change from being 'natural' or 'social' because it can be both at the same time, but by specifying and demarcating fields of enquiries and presenting analytical perspectives enables approaches transcending determinism and constructivism.[11] Being an approach encouraging historical studies of hydrology, hydro-history and hydro-archaeology and the relevance of the physical world and the physical aspects of the water system and its relations to society and action, it also differs from all types of system theories that are only concerned with the social or with social variables.

A water system approach may open up new avenues to understanding these mutual relations. It consists of three layers, which should be analysed in connection with each other:

1. The physical and natural waterscape;
2. The modification of, and adaptation to, different water systems; and
3. The cultural, instrumental and religious ideas about water at a given place.

The use of the terms 'first', 'second', and 'third' layer of the water system does not signify any ordered hierarchies of importance or categories; they are separate, distinctive and related layers. The different levels are meant to designate analytical ways of separating and discussing the complex nature–culture relationships without falling into the trap of ecological determinism or social constructivism, by acknowledging that water is both culture and nature at the same time.[12]

Importantly, all the chapters in this volume include all three levels, although with different emphases in the analytical and empirical discussions. Some aspects are highlighted with regards to the respective layers in the water system but, as will be indicated, all chapters could have been used to exemplify all layers. Hence, although the layers are analytically, empirically and theoretically separate and distinctive, they are integrated in historic and social contexts, which this volume will attempt to illustrate.

THE FIRST LAYER: THE PHYSICAL AND NATURAL WATERSCAPE AND FOOD

This approach rests on the premise that the physical world exists and has existed independently of humans, and will continue to do so, even though humans may also significantly alter the natural world (see Level 2). Today, the climate change discourse has shaped parts of the premise seeing nature as very much influenced by humans and consequently not existing

independently of human activity. At the outset, one may point to three aspects. First, when climate scientists are taking deep-core samples from the ice in Antarctica, going back several thousand years, these provide a description of nature and of waterscapes not impacted by societies. Second, although interpreting and understanding this is, of course, a (social) construction, it does not mean that the various bodies of water have never existed prior to our understanding. On the contrary: it is as 'non-impacted' that it becomes relevant data both to understand climate and society. Third – and perhaps the most important from a water system perspective, due to its implications for analysing the consequences of human induced climate change – as far as we know today, the amount of water circulating on earth as part of the hydrological cycle is basically constant. *This* is water as external nature independent of humans; climate change may influence where and when there will be more or less water as rain or floods or the melting of glaciers, but the overall amount of water circulating in the atmosphere and existing on the planet remains the same. Or to use another example: the mere fact that humans may pollute and poison a pristine lake does not 'culturalize' or 'de-naturalize' the water – it is still external nature and water, but in a deteriorated state from a human perspective. Ultimately this water will evade human control and influence, primarily because the sun evaporates water, which then comes back as clean water. The possibility of humans to have an impact (often radical) on nature and waterscapes, and thus also on the relations between societies and water, does not make water, as nature, something of the past. The hydrological cycle is still an external physical fact, while the hydro-social cycle – the way water travels through societies – influences it and is influenced by it.[13] Analyses on this layer can, for example, be concerned with reconstructions of how different food systems in varying and changing waterscapes, from deserts to tropical rainforests, have enabled certain adaptations and technological innovations at different points in history. Concepts like water zones give attention to such relations between systematic differences in waterscapes and flora and fauna and agricultural food regimes.

Fridtjov Ruden highlights these aspects of water as external nature, and at the same time the human ability to severely pollute pristine waters, by analysing the role and importance of African mega-aquifers.[14] Water exists externally to humans and this may represent a huge potential for Africa's future. It is estimated that beneath the Sahara, some 5 per cent of the world's freshwater is found and stored in deep mega-aquifers. Some of these deep waters are probably more than 1 million years old, predating humanity, and have existed independently of humans until their recent discovery. All over Africa there are large aquifers of hidden waters and there are probably many that remain to be discovered. If developed well and exploited carefully, these mega-aquifers may contribute significantly to securing the future water needs of Africa in the long-term. However, in

many of these geological contexts there are also large oil reservoirs above the mega-aquifers, and pollution from oil extraction may pollute the pristine waters for eternity, causing ecological disasters of unparalleled proportions.

A long-term perspective on food production, or a hydro-historical and hydro-archaeological approach to food production, makes it clear that what matters is that for all people at all time the presence or absence of water is a reality and not only a social construction. When droughts hit the African continent and the life-giving rains never come, this is an external nature people have to adapt and relate to, whether it is part of the natural annual precipitation variability or accelerated by human induced climate change. Whether caused by the absence of rains for years, or by irregular and devastating floods, throughout history too much or too little water for food production at the right time for cultivation has been a matter of plenty or famine, and life or death. The physical water world is a premise for human existence and adaptation. Importantly, these water worlds have always been changing as part of natural variations or accelerated by climate change and drought, and have regularly haunted the continent throughout history.

Marcel Rutten analyses the Maasai pastoralists and their adaptive strategies to drought, in particular the drought in Kenya in 2008–9.[15] For a Maasai to survive on a diet of milk and meat from cattle, it is estimated that it requires about ten cattle per person; in 2008 the ratio was 1:5, which was partly due to population increase. The number of cattle is dependent upon the rainfall, but social changes and modernization also affect the traditional livelihood. While hydrological and meteorological droughts are scientifically defined in amounts of precipitation and water availability, the Maasai have culturally defined perceptions of drought, linking failing rains to hunger, since the cattle become thin producing little milk, with the lack of food resulting in crisis for herds and humans, and subsequent disaster for livestock, ultimately causing death. During the 2008–9 drought as much as 90 per cent of the herds were lost, although many of the cows did not die from the drought itself but rather from disease. Thus drought is not mere absence of water, but includes a broad spectrum of multiplying factors, which lead to extreme adaptive strategies involving great mobility searching for water and fodder, with severe implications for social life and well-being.

From the neighbouring country, Terje Oestigaard discusses the 2011 drought in East Africa, affecting the Sukuma agriculturalists along the southern shores of Lake Victoria in Tanzania.[16] The drought affected as many as 13 million people and an estimated 500,000 were affected in Tanzania. Being dependent upon the erratic and unpredictable rains is a gamble where the farmers cannot afford to make the wrong decisions with regards to what to grow and when and on which agricultural plots, but still

they do. However, all strategies are in vain when the rains fail. While pastoralists have an option, no matter how meagre or small it may be, to take with them the cattle and search for water and food elsewhere, agriculturalists do not. As one farmer put it, one cannot move the land – farmers have to stay where their land is and wait for the rain. However, farmers and pastoralists alike need money for food, and during periods of drought it alters the social structure. If they cannot move their land, they can move themselves. Migrant work is an option when money matters, and although the market economy puts other limitations on rain-fed agriculturalists, despite the suffering and hardships the current drought was seen as easier to survive than those in the early-1980s, when it was more difficult to buy food even if they had money.

To what extent these two droughts were worsened by climate change is a matter of debate, but the current climate change challenges are generally expected to affect Africa harder than other continents. This has to be understood from a water perspective, and there are hydrological reasons for this increased future vulnerability. Although there are always hydrological fluctuations, this inter-annual variability and availability has been greater and more unpredictable in Africa, which historically has resulted in extremely robust resilience and risk-management strategies. This can be illustrated through varying rainfall precipitation, though not only in mere measures of millimetres of rain, since the very rainy season has a specific character on different continents. In parts of Asia, for instance, the monsoon winds lead to a more well-watered agriculture than compared with large parts of Africa, directly impacting food production. The particular condition that has framed large parts of Africa is the great agro-ecological variability within even small territories: it may rain sufficiently in one village but not in the neighbouring one, etc.[17] Given that ecology is a very broad concept including numerous understandings and many aspects of 'nature', we would rather propose a more specific term: *agro-water variability*. This directs attention to the role of water in different food production regimes, and by using it as a common denominator, as a sort of methodological entry-point, the greater agro-ecological variability might be easier to reconstruct and analyse.

Starting with mere precipitation, from the tropical rainforests receiving up to 5,000 mm rain each year to the deserts in the Sahara virtually without a single drop of water for years, the agro-water variability of Africa is extreme. But the agro-water variability of Africa is not a gradient, with fading amounts of precipitation from the rainforests to the deserts – from 5,000 mm to 0 mm; if this was the case the predictability and adaptability would have been rather straightforward. If it is one thing that characterizes statistical averages concerning precipitation, it is that the actual rainfall in a given year is hardly ever the average: more often than not it is extreme one way or another. In other words, there is hardly ever a 'normal' year; the erratic and unpredictable rainfall patterns become

'the norm'. Moreover, the total inter-annual amount of precipitation is not always the most relevant measure. If there are two rainy seasons – the long and the short – what matters fundamentally for agriculturalists is that the right amount of water comes at the right time. In particular, rain-fed agriculture is highly vulnerable to erratic precipitation patterns. If the rains fail, or are abundant at the wrong time for the cultivation season, it may have devastating consequences. Moreover, too intensive rains may destroy crops, which also need sun; and the perfect balance between heavy and light rain for some days, then sun and more good rain, and so on, are parameters that nobody can predict but which farmers are dependent upon for a successful harvest. Importantly, as pointed out above, the actual rainfall may also be very specifically localized, even within small areas. As a consequence, not only are what and when to grow fundamentally affected, but also *where* within a village, creating systems of multi-plot approaches aimed at predicting and reducing risk. Understanding the social consequences of this great agro-water variability in time and space is crucial when comparing most African food regimes with, for instance, development and the Green revolution in Asia.

The dependency on which type of water also relates to technological innovation in a given time period, creating varying opportunities and varying social development; and closeness to oases and rivers in dry environments offers other possibilities than dependency on the life-giving rains. Prehistoric subsistence and habitation patterns show a strong correlation with adaptation and the specific utilization of different water bodies.

Elena A.A. Garcea analyses semi-permanent foragers in North and West Africa from an archaeological perspective, going back 10,000 years.[18] This was a time when there were huge ecological changes. Lake Mega-Chad had a maximum surface area of about 340,400 km^2 in two periods from 7,400 to 8,500 years ago. Still, the semi-permanent hunter-fisher-gathers were living in aridity-prone areas and the desert foragers adapted aquatic livelihood subsistence patterns along the main bodies of water. Comparing two sites only 20 km apart along the Nile in today's Sudan with a site in the Ténéré desert in Niger in the Sahara, the settlement patterns show clear differences in adaptation where the various bodies of water in dry environments were like 'islands in the sea'. Although hunters and gatherers are commonly believed to be on the move, and they were, livelihood strategies in arid environments were also more complex. The access and closeness to water resources enabled greater investment in territoriality and semi-permanent settlements, with thick layers of continuous habitation for a long time, which also included heavier tools and equipment, like non-portable pottery and grinding stones.

Louise Bertini addresses dependency and adaptation to the fluctuating Nile from another perspective, namely swine husbandry practices

in ancient Egypt.[19] Domesticated animals accounted for more than 50 per cent of the faunal assemblages by the start of the Early Dynastic period (*c.*3000 BC). In ancient Egypt, cattle were highly valued, but remains of pigs show from settlement sites that pigs were one of the most common domesticated animal. Pigs were for subsistence, and, as a vital source of protein, were exempt from taxation. Based on meticulous analyses of dental defects of the pigs' teeth – since tooth growth is an indication of different degrees of stress (environmental stress included) – there were two different swine management practices: free-ranging and perennial. In particular, with regards to free-ranging pigs, different tooth growths indicate different stress factors related to ecological changes caused by fluctuating Nile levels (high or low floods) impacting on the pigs' environment and foraging range. Not only may the degree of agriculture determine the extent of swine husbandry practices, but, perhaps more importantly, the actual annual flood – and hence pigs and their environmental stresses – may be an indicator of the fragility of the ancient Egyptian agricultural adaptation despite the fact that the flood came each and every year, although in fluctuating levels.

A long historical perspective will allow us to explain why it is crucial to go beyond the social reductionism inherent in much of the social sciences when studying societies' development trajectories. Johann W.N. Tempelhoff analyses the history of water, migration and settlement in southern Africa from a long-term perspective (200–1850 CE).[20] In the latter part of the nineteenth century, settlers became aware of water shortages and the perception of a sub-continent that was in the process of dying and 'drying out' was put forward. Through a meticulous historic analysis Tempelhoff shows how varying water availability was the key value to land, and he shows how water created both opportunities and limitations to societal development. What becomes clear is the non-reductionist ways people have adapted to the changing water-world in various societies, including mobility patterns among hunters and gatherers to the civilization of Great Zimbabwe. The history of the Iron Age in southern Africa is not a narrative of the rise and fall of societies in relation to water. On the contrary, it is a story of how water availability has been a fundamental part, where human ingenuity has created resilient and resistant processes, and the collapse of some structures and societies has led to the emergence of new forms of developments in dynamic ways.

From another perspective, Andrew Ogilvie, Jean Charles Clanet, Georges Serpantié and Jacques Lemoalle analyse water and agriculture in the Niger Basin through the twentieth century.[21] Throughout the century drought has been a recurring problem, to varying degrees, whilst at the same time in the southern areas, with their abundance of water, the excessively moist climate has created yet other problems like the

tsetse fly attacking livestock. The irregularity of weather fluctuations and the dependency of the annual rains have structured livelihood and livestock practices. While pastoralist herders in the Sahelian semi-desert grasslands have to balance the herds' need for water and food on the one hand, with the physical effort to find where water and fodder are available on the other, agriculturalists aim to reduce vulnerability by diversifying crops. But, when the rain fails over a number of years the consequence has been severe famine, like the Sahelian famines of 1972–3 and 1983–4. Yet failing rains may also, paradoxically, create more runoff in rivers, at least initially. Changes in land use and land cover, including forest degradation, have reduced the water-holding capacity of the soil from the 1970s and, as a consequence, the runoff in some of the Sahelian catchments increased despite of the reduction in rainfall.

As a last example, Raphael Tshimanga analyses contemporary hunters and gatherers in the Congo rainforest.[22] In tropical climates a rainforest is generally defined as an area receiving more than 1,600 mm of precipitation annually. Although it is commonly believed that there is plenty of water the year around in rainforests, Tshimanga shows that even in rainforests there is great seasonality, impacting human adaptation. These seasons where the rain is unevenly distributed – and there are even dry seasons, relatively speaking – are structuring the life and subsistence patterns of hunters and gatherers. The appropriate and preferred season for hunting certain types of game depends on the rains. In other seasons, gathering is the dominant subsistence practice, and local variations in the ecology, even in rainy areas like rainforests, create specific opportunities and limitations.

This volume has pointed out some of the extreme variations in precipitation patterns across the African continent from year to year, affecting inter-annual fluctuations in river inundations, but also within a year at different seasons at a given place. It has also shown some of the extreme variability and unpredictable changes in the actual natural and physical water world and how it has impacted rural life. Different food systems in varying and changing waterscapes, from deserts to tropical rainforests, have enabled certain adaptations and technological innovations at different points in history. We suggest that terms such as 'water zones' will be useful in analyzing patterns of food regimes,[23] and specific agro-water variability within water zones, all the time acknowledging that these adaptive innovations and developments have also been integral to specific societal organization. Since variation and fluctuating patterns of water zones are products both of nature and human ingenuity, this term also directs our attention to the second layer of analyzing food within a water perspective: human modifications of the waterscape.

THE SECOND LAYER: HUMAN MODIFICATION OF THE WATERSCAPE AND FOOD PRODUCTION

The human modification of particular waterscapes is important with regards to food production from the smallest to the largest interventions, but in Africa and elsewhere it is very important to analyse how these interventions are framed and influenced by the structural properties of the physical waterscape. In sub-Saharan Africa today, more than 90 per cent of the agriculture is rain-fed, and even though the rains fall from above, the waterscape has to be modified intensively to secure a bountiful harvest. This sole dependency on the seasonal rains necessitates the utmost preparation of fields for a successful harvest – from tilling the soil to the careful supervision of the fields throughout the season. Dependency on one single, and at times highly variable, source of water may require more intensive and thorough modification of the fields and the waterscape, since the margin between a successful and failed harvest, depending as it does on the fluctuating rains, is an act of balancing on the edge.

The most common form of modifying the waterscape for extensive agriculture is irrigation. Matthew V. Bender analyses the traditional irrigation system among the Chagga farmers on Kilimanjaro in Tanzania from a historical perspective.[24] Once heralded by the early colonialists as indigenous ingenuity, from the 1920s onwards the irrigation system was seen as wasteful and indeed as increasing water scarcity on the plains. By the turn of the twentieth century, about 80,000 lived on the mountain, and although the mountain is renowned for its icecap at the top, water scarcity and erratic rain fluctuations were prevalent, and the furrow-based irrigation system was a sophisticated adaptation to the unpredictable nature of water. The change in colonial perceptions of the irrigation system was due to several factors: there were a number of prolonged droughts, the American Dust Bowl (1930–6) generated fear that the mountain would be drier, population increase created greater pressure on resources, and there were conflicting interests with regards to water use. British settlers endeavoured to transform the water regime on Kilimanjaro, a policy that post-independence Tanzania continued. But the resilience of the agricultural practice persisted throughout much of the twentieth century, and today's decline is mainly due to land shortage, socio-economic factors and job opportunities away from the mountain, and not due to centralized policies.

While only a limited amount of the total feasible irrigation potential is fully developed in Africa, the possible expansion of irrigation is generally seen as limited. However, one should treat the different statistics with caution because there are grading differences between extensive rain-harvesting techniques, traditional irrigation and full-scale industrial projects. Globally, about 20 per cent of cultivated land is irrigated. This land produces 40 per cent of the world's food. As opposed to rain-fed

agriculture, irrigated agriculture is largely dependent upon dams. In the period from 1945 to 1990 more than a 1,000 large dams – i.e., with a height at least 15 m or with a reservoir capacity of 3 million m^3 or more – were built in Africa for irrigation and electricity purposes.[25] Many of the dams were built solely for hydropower, whereas in those cases where they are multipurpose dams, there are often tensions and internal domestic discussions regarding the amounts of water that should be used for electricity (industry) and agriculture (irrigation) and at which time of the year, directly affecting the overall agricultural production.

Pierre Morand, Famory Sinaba and Awa-Niang Fall study the traditional fishers, herders and rice-farming communities of the inner-Niger Delta and the consequences of lower floods, mainly due to recent dam building.[26] In the delta, there is what is called a 'social ecological system', where different ethnic groups have specialized in different food products: milk, fish and rice. Although the system among the herders, fishers and farmers is not egalitarian, it has enabled cooperation and exchange between the groups utilizing different resources in the same ecosystem. All these production systems are dependent upon the annual flood, which is weakened by several dam constructions upstream. It is estimated that a 1 cm reduction in the water height during the flood peak implies a loss of about 65 km^2 being inundated. Currently, the existing dams result in losses on inundated areas of between 1,200 km^2 and 2,850 km^2, and this is expected to increase to between 3,500 km^2 and 6,500 km^2 with new dams. Consequently, the fishers, herders and farmers are negatively affected in different ways by the reduction of the flood, and although the dams enable hydropower and irrigation, it stresses the fact that large-scale water structures have huge social and economic consequences for the better or worse.

Maurits W. Ertsen discusses the French colonial irrigation plans and schemes in West Africa and demonstrates a global context and influence of these schemes from the early ideas and plans to today's successors.[27] From the early nineteenth century, the French colonial administrators developed schemes in Senegal inspired by their experiences in the Mekong valley. Based on the results in Senegal, the French were convinced that even larger projects could be developed in the central delta of the Niger River in Mali. French engineers had visited and learnt from British India, and later from the Gezira scheme in Sudan, aiming to turn the Niger River into a 'French Nile'. While the irrigation schemes were not as successful as their British counterparts, the purpose of the schemes was not only colonial exploitation by France for export of cash crops, but also to serve the food needs of the colonies and to be a grain basket for French West Africa. After independence, including the period from the 1980s with development donors and market liberalism, the overall structures of the colonial schemes continued, although with significant changes. From 2005 onwards, these former colonial irrigation

schemes have been allocated to national and international investors, being part of what has been described as the current wave of 'land-grabbing' or 'land-acquisitions'.

Turning to another French colonial area, Brock Cutler studies urban–rural relations in the modern Maghreb.[28] Common throughout many areas and regions in Africa, absence or presence of water is not only a matter of hydrological parameters and rainfall patterns, but also literally man-made constructions on the ground, part of explicit policies whether colonial or not. Moreover, there is often a transfer of water, food and resources from rural areas to urban areas. By using historic examples from Morocco, Algeria and Tunis, Cutler shows that the most relevant question is not always the total amount of water, but who *controls* and *transfers* the water through large-scale infrastructural projects. From the French colonial period onwards, water has been directed to urban areas, and even there only privileging certain sectors of towns, while the rural areas and the agricultural needs for water have been marginalized. In the twentieth-century this has been implemented further within the frame of modernization, where the challenge has been that, although agriculture has been the largest water consumer, it has nourished fewer and fewer people while at a same time there has been an explosive urban growth demanding more water.

This points to the fact that water has always been transported from one location to another, either in the form of water or as food. Although jars, pottery and today's plastic bottles and jerry cans are often seen as simple tools, the importance of these in water and food analyses cannot be underestimated. Smallholder agriculture is predominantly a female domain and carrying water is usually solely the work of women. Moreover, food preparation and cooking in domestic households is traditionally the task of women. Not only are gender relations involved at all levels, but it also points to the outcome of agriculture and food production: food and consumption of food, but also redistribution of food and transport over long distances whether these transactions are embedded in social relationships or merely export for cash.

In a wider perspective the different means and techniques for transport of food have to be included in this second level of a water system approach. Food may be transported on the head while walking, or via long-distance transport on the backs of camels, on boats along the main watery arteries or on modern lorries and even in planes, connecting distant localities in the rural hinterland to the global world.[29]

Although food is usually what one thinks about when it comes to agricultural production, throughout history water and land have provided resources for other types of harvest – non-food items – which sometimes are in competition with food production if the water and land resources are limited. This raises the fundamental questions of what water and land are used for, and how food systems are part of other economic systems which

are dependent upon the same resources. The colonial projects were, to a large extent, preoccupied with cotton production – agricultural practices that have continued to today. Cultivation of flowers is another practice which is highly water intensive. Gessesse Dessie focuses on a type of agricultural production that is not much discussed, namely using water and land for drugs.[30] Ethiopia is one of the world's main producers of khat. Among smallholders, khat production amounts to about 20 per cent of the average land holding, and it is the most lucrative cash crop by far and among the top five most important foreign currency earners. Khat production is highly water intensive and the replacement of food with khat production represent a huge loss of calorie production on the one hand but also enables a greater income which may secure food purchases on the other hand. Thus, replacing food with drugs may increase food security at an individual household, at least in the short run.

Whereas khat production for the international market in Ethiopia is an individual household strategy among Ethiopian smallholder farmers, there is another recent process taking place on a grand scale on the African continent, which has been labelled 'land-grabbing' or, more neutrally, termed 'land acquisition'. These investments are to a large extent foreign, although there is increasingly domestic investment in parallel. Atakilte Beyene and Emil Sandström present an overview over recent land and water acquisitions in Africa and its relation to food production.[31] Whereas there are varying estimates, in the media and the academic literature, a thorough investigation reveals that the actual numbers are probably significantly less than previously reported, and that in the period 2007–14 the land deals in Africa accounted for about 20 million hectares. Moreover, there is a huge gap between intended and operational deals. In their discussion, they focus on the water question. Most of the crops cultivated as part of the land deals are water intensive, but recently there has been a gradual shift to a greater focus on food production than, for instance, bio-fuel cultivation. Large-scale investment often requires irrigation to safeguard the profits of investors, and although most of these deals are not transparent, the water question is one of the main drivers for foreign (and national) land acquisition, often facilitated by changing land laws.

Economic profit motives are major drivers for much of the recent agricultural development and investment. National and international actors invest in African water and land for export of food and cash crops both within and beyond the continent. Although food has always been integrated into spheres of redistribution, exchange and sale, agricultural products are increasingly becoming seen and exchanged as a commodity on the global finance market, with subsequent implications for investment in African water and land. To what extent these processes are increasing or jeopardizing Africa's food security is an ongoing debate, but more and more of the most fertile agricultural land is

used for cash crops for foreign export instead of supplying national food needs. In practice, this also means that much of the water used in agriculture flows out of Africa.

Thus, the second level analysing the relationship between food production regimes and water consists of the human modifications of the waterscape and adaptation to changing water worlds. This includes the preparation and tilling of fields in areas dependent upon rain-fed agriculture up to mega-dams providing water for large-scale irrigation schemes. It also includes the small pottery jars and fishing hooks up to large industrial fishing boats and mechanized farming and fertilized schemes, as well as modes of transport both within and outside the continent. In one way or another, all these practices and equipment relate to the actual physical waterscape and the ways in which people at all times have modified and adapted to their actual water worlds, but this happens in social and political contexts structured and governed by ideas and laws.

THE THIRD LAYER: IDEAS AND MANAGERIAL CONCEPTS OF WATER AND FOOD PRODUCTION

All human activities and ideas are obviously part of social, cultural, political and religious spheres in varying degrees. The third analytical layer of the water system approach addresses the social and human context in which practices related to water take place. Tilling the soil with a hoe is a practice shared by most smallholder farmers, being an adaptation to and modification of how the water runs through and across the fields, but prayers to the gods to let it rain when rain is needed are also among the wide arrays of practices that can be studied within this analytical perspective. These social practices may be embedded in centuries-old traditions and belief systems or modern conceptual frames. Life-giving rains have been intimately connected with ancestors and rainmaking rituals, and have been seen as precious gifts from the Christian God or Allah, whilst the absence of rain has been viewed as a penalty by the gods (or ancestors) for sinful conduct in the community, or the result of human induced climate change. The choices of what to grow, and thus what kind of water management is necessary – food for the family or cash crops for sale – also depend on a wide range of factors: individual taste and preferences, access to markets, and economic stress (for instance, how many children attend school), bridewealth and social commitments in the wider family, etc.

Traditional farming is also regulated by laws and land and water stewardship. Land tenure is the customary practice of managing and using the land and the way it might be transferred through generations or shared within and among families, villages and beyond. Land tenure systems may

not be formalized from a state perspective, and in countries like Tanzania and Ethiopia the state is the ultimate owner of all land. Yet customary practices define user rights, and these are often embedded in other social relations in the extended family. Access to land and natural resources is crucial, but in many customary systems the introduction of free liberalism and the market economy is not necessarily applicable, and centuries-old traditions regulate who has access to which type of water and land.

In all cases, behind the basic human need for food, the decisions regarding what to grow where, when and by whom, and not the least who should be the consumers in which regions and at what time, are deeply embedded in cultural, social, political, juristically and religious domains. These are not merely recent conditions or contexts in which food production is situated, for throughout history all food-producing processes have been deeply rooted and structured by socio-cultural and juridical structures regulating social and political organizations. The Nile Delta in Egypt may illustrate such historic structures and processes from different perspectives.

Katherine Blouin discusses the generally held perception that the Nile Delta was a breadbasket in antiquity and the Roman period.[32] The size of the delta is approximately 26,000 km^2 compared to the 9,900 km^2 of the Nile Valley. Although the written papyri texts are scarce due to the humid conditions in the delta compared with the drier conditions in Upper Egypt, there are some historic sources and these indicate highly developed local water management practices in combination with a state-organized system supervising and integrating taxation, storage and transport facilities. The agricultural land was divided into three types of land categories: grain land; vineyards and gardens; and pastures – all of them relating to the local ecology and the ways in which the Nile annually inundated the areas. Grain cultivation was the main agricultural crop, constituting more than 90 per cent of the arable land, but areas not well suited to this cultivation were intensively utilized for other crops and husbandry. This extensive intensification in combination with diversification testifies to the important role the delta had in antiquity, thus supporting the notion of being a 'breadbasket' not only for the region but also for the Roman Empire.

Alan Mikhail analyses the role of the Nile and food export in the early modern Ottoman period.[33] After the Ottomans conquered Egypt in 1517, Egypt became the main source of food supply and the breadbasket for the whole Ottoman Empire. The Ottomans had a particular interest in, and profit from, controlling and maintaining the irrigation systems of Egypt. Egypt literally produced the energy empowering the muscles of the political powers in Istanbul, controlling the provinces from Morocco, Syria and Yemen. After Istanbul, the first destination of Egyptian grain, came Mecca and Medina. The annual pilgrimage and festival held in Mecca – the *ḥajj* – was secured by food where Egypt was the main supplier.

The practical importance for the Empire in facilitating this utmost religious pilgrimage is evident by the fact that Istanbul sent one of the most trusted functionaries to oversee the work and transport carried out in Egypt. Thus, the Nile waters and the fertile fields of Egypt increased the food security of the Ottomans, enabling the Empire to control vast areas, physically as well as spiritually.

Politics and power relations play fundamental roles in food production. Tobias Haller discusses the role of institutions and power relations for water governance and food resilience in the African floodplains.[34] Although floodplains and wetlands have often been a common pool resource, this does not mean that they have not been managed by local communities in pre-colonial times. Local institutions regulated and controlled who could use which type of resource and for what purpose at a given time at a certain place – for instance, drinking, fishing, pastures, wildlife, forestry and irrigation. Today, this would have been sustainable water use, but the aim was to secure livelihoods and reduce risk, although the outcome proved to be sustainable. Thus, contrary to Hardin's theory of the 'tragedy of the commons', common pool resources were not depleted. However, with colonial and later independent states' centralized control over these recourses, the belonging and ownership to these resources were alienated from the local people, who were no longer able to continue their customary practices protecting and preserving their common resources for the betterment of them all. This is turn has led to a situation which resembles Hardin's argument where people started to behave as if the water and the resources were open and freely accessible to all, and given the mistrust in the state and the weakening of local traditions and institutions, people started profiting as much as possible, and preferably before everybody else.

From another perspective, Tor A. Benjaminsen analyses land-use dynamics along the Niger River in Mali in the region where the river 'bends'.[35] This has historically been a scarcely populated area dominated by pastoralism. While it has generally been held that there has been an increasing desertification in the Sahel due to overuse of local resources, it seems that the fluctuating changes are closely related to the annual rainfall rather than to livestock numbers. Contrary to another postulate, namely that the Sahel is 'overpopulated', Benjaminsen argues that it is underpopulated and therein are some of the challenges to agricultural production causing other conflicts. This challenges Malthus' thesis, since there are not enough people for intensive agriculture, hence supporting Boserup's thesis that population increase is a prerequisite for agricultural development and improvement. In this region, pastoralists reluctantly adopted farming as a livelihood because it was seen as too risky and generating too little income. However, when the land was open and vacant for longer periods, other sedentary groups moved in and started cultivating the land, causing conflict when the pastoralists returned.

Politics and law are also involved in other ways with ecological implications as well with regards to food security. Jeppe Kolding, Paul van Zwieten and Ketlhatlogile Mosepele start with the obvious – but still often neglected or under-communicated fact – that fish is food, and in particular inland fish plays a fundamental role in diets.[36] In Africa, as elsewhere, fisheries have been regulated, with the aim of protecting the small fishes from over-fishing, based on the assumption that if the small fishes are caught, it may jeopardize the whole ecosystem. This assumption is challenged from new theoretical and empirical approaches. While most fishermen will argue that their catches are reducing, this is most likely because there are more fishermen and not fewer fish, while at the same time the total catch is the same or increasing. Given that there are seemingly fewer big catches, fishermen reduce the net sizes and are 'fishing down', going for the smaller catches. This is generally interpreted as a sign of over-fishing and crisis, but it may be the other way around – a sign of a healthy ecosystem. In the nutritional pyramid, big fish are far above predators in the animal world, while the greatest biomass production takes place at the bottom. Hence, a focus on small fish may not only enable more sustainable ecosystems, contrary to current policies enforced by law, but also offer an untapped resource of more food.

The Great Lakes like Lake Victoria have obviously been important for fishing throughout history, but subsistence practices are yet structured by other practices and belief systems. Andrew Reid analyses the importance of bananas in the Buganda kingdom in today's Uganda.[37] Situated by the shores of Lake Victoria, the second largest lake in the world, water played a prominent role not only in the subsistence, but also in the cosmology of the Bugandas. The lake was called *Nalubaale*, which means 'the place of mother *lubaale*'; *lubaale* probably meaning spirits or even ancestors. Reid shows the complex dynamics and relations between rain-fed farming on land and lake adaptation. The year-round rainfall pattern created optimal conditions for banana cultivation. While bananas are highly nutritious, they lack proteins, and fish was fundamental in the diet. According to tradition, bananas were associated with the spirit Kintu, or the creator of Buganda, or with the Ssese Islands. Throughout the history of the Buganda, royal and religious powers were contested. About 75 per cent of all Ganda shrines were located at the Ssese Islands in Lake Victoria and the most important spirits and ancestors were related to water. Thus food, and in particular bananas, were intricately interwoven in the religious and spiritual realms of different water bodies with emphasis on rain and the lake.

From another, and contemporary, perspective Jessica Kampanje-Phiri and Dean Kampanje-Phiri eloquently point out that food is not just food or substances of caloric value, even in times of crisis and during drought.[38]

Among the Chewa of Malawi, white maize has a special social and symbolic value in the community, although this crop is not indigenous in the traditional sense. White maize symbolizes high status and wealth, whereas dark coloured maize is associated with poverty and low rank. During the 2001–6 hunger crisis donors provided cheap and subsidized American maize as food aid. This maize, however, was not the white variety but the coloured one. Not only was this food aid perceived as contradictory to the cultural and cosmological structure among the Chewa, but some even claimed that it smelled like 'dirt'. While foreign aid workers were distressed that the food aid was not perceived as appropriate food even in times of crises, it also challenges what 'food security' means, since in today's accepted definition it is stated that it includes 'food preferences for an active and healthy life'. Food is intrinsically linked to social and cosmological life; not only is it basic to human life and survival but it is also part of the foundations of society and religion, and in many cases these perceptions are stronger and more pervasive than the need for mere calories.

Food is not only something to eat in order to survive, but a way of living in a broad sense. Intriguingly, this is also possible to trace in archaeological material dating back to the very origins of domestication in Africa. Randi Håland analyses the early aquatic sites along the Nile going back 10,000 years. Domestication and sedentism were closely related to different food systems. While Egyptian cuisine was related to the Near Eastern cuisine based on bread and baking in ovens, Southern Sudanese cuisine was similar to the African savannah cuisine based on porridge/beer and boiling technology. Rather than using grains for bread, in the southern areas aquatic resources and wild grains were cooked into a stew, or made as beer, which not only enabled a growing population as it reduced the vulnerable infant stage when young children passed from breast milk to solid food, but it was also a social process, most likely driven by women, challenging other theories of societal hierarchy. Moreover, in an area where different groups with distinct languages were living, it seems like the pastoral Cushitic-speaking people developed a fish taboo in relation to their fish-eating Nilo-Saharans. Thus, from the earliest times, cultural and religious perceptions of food have been integral to the very evolution and development of these food systems.[39]

PAVING THE WAY FOR A NON-REDUCTIONIST APPROACH

Whether the context of study is hunters and gatherers in the rainforest, rain-fed agriculturalists in semi-dry environments, or mega-dams and irrigation projects based on market liberalism, a water system approach opens up possibilities for analysing water and food relations as both culture and nature as well as how these cultural

and natural factors mutually influence and impact on each other, creating possibilities and limitations for food production and different societal developments. We suggest that studies of food production and food-producing regimes will benefit from a water system perspective.[40]

By separating the distinctive processes at work, while at the same time showing how the physical, managerial and political and cultural are related and interconnected at various levels and in different contexts, both environmental determinism and social reductionism can be evaded. All three levels do not have equal explanatory strength and importance in a given study. It is very important to realize that the approach opens up and allows emphasis for only one or two of the levels, as with many of the chapters in this volume.

This volume shows that Africa's history and food production cannot be understood properly without locating the practices within the continent's particular water systems. While it has never been the intention of this volume to come up with practical policies for Africa's current and future food insecurity (and as this volume shows, there can never be one template for all, given the extremely varied ecologies and historically specific adaptations), historical studies do, however, offer insights into processes and practices that have worked in the past and still do. Despite the challenges that Africa as a continent has faced with regards to food security throughout millennia, she has also prospered and managed extreme situations remarkably well, despite all the hardships and suffering. As many of the chapters in this volume illustrate, the knowledge and experience based on centuries of traditions have enabled a highly functioning and well adaptive structure to extreme, seasonal and varied ecological conditions and water availabilities in time and space. Rapid and dramatic interventions and changes in these resilient structures, whether colonial or not, have had deep impact on society and development, in some cases radically increasing local and national food security, in other cases not.

Whether within a past or present context, water has been, and will be, at the centre of societal organization and development. The chapters in this volume thus present a different history of Africa by showing the intimate relation between water and food production in the rise and resilience, but also the decline and challenges, of societies in highly diverse and changing water worlds. What becomes clear is that although the actual agro-water variability factor is fundamental to the development of different food-producing regimes, the physical water world at any given time and at any given place creates possibilities and limitations that through human ingenuity have given birth to a wide variety of rural and food adaptations and societal organizations.

NOTES

1 We would like to thank Professor Kjell Havnevik for his constructive comments.
2 Clausen, T.J. 2012. 'Introduction'. In Jägerskog, A., Clausen, T.J. (eds), *Feeding a Thirsty World – Challenges and Opportunities for a water and Food Secure Future*. Report No. 31. Stockholm: SIWI, pp. 6–12.
3 Tvedt, T. 2012. *A Journey into the Future of Water.* London: I.B.Tauris.
4 According to the Food and Agriculture Organization.
5 Trigger, B. 1994. *A History of Archaeological Thought*. Cambridge University Press. Cambridge, pp. 75–94.
6 For African developments, see Mitchell, P. & Lane, P. (eds.). 2013. *The Oxford Handbook of African Archaeology*. *Oxford Handbooks in Archaeology.* Oxford University Press. Oxford.
7 See Mitchell, P., Lane, P. (eds). 2013. *The Oxford Handbook of African Archaeology. Oxford Handbooks in Archaeology.* Oxford: Oxford University Press.
8 Luan, Y., Cui, X., Ferrat, M. 2013. 'Historical trends of food self-sufficiency in Africa'. *Food Security* 5: 393–405.
9 Bryceson, D.F. (ed.). 2010. *How Africa Works: Occupational change, identity and morality in Africa.* London: Practical Action Publishing.
10 Juma, C. 2011. *The New Harvest: Agricultural Innovation in Africa.* Oxford: Oxford University Press.
11 See, for example, Tvedt, T. 2010a. 'Water systems, environmental history and the deconstruction of nature'. *Environment and History* 16(2): 143–66; Tvedt, T. 2010b. 'Why England and not China and India? Water systems and the history of the industrial revolution', *Journal of Global History* 5: 29–50.
12 For a more thorough discussion of this approach, see Tvedt, T. 2016. *Water and Society: Geopolitics, Scarcity, Security.* London: I.B.Tauris.
13 See Tvedt 2015 for a discussion of this set of interconnected concepts.
14 See Ruden, Chapter 22 of this volume.
15 See Rutten, Chapter 12 of this volume.
16 See Oestigaard, Chapter 13 of this volume.
17 Kjekshus, H. 1996. *Ecology Control and Economic Development in East African History: The Case of Tanganyika 1850–1950*. Second edition, London: James Curry.
18 See Garcea, Chapter 1 of this volume.
19 See Bertini, Chapter 3 of this volume.
20 See Tempelhoff, Chapter 5 of this volume.
21 See Ogilvie, Clanet, Serpantié and Lemoalle, Chapter 10 of this volume.
22 See Tshimanga, Chapter 14 of this volume.
23 For discussion and definition of this term, see Tvedt 2016.
24 See Bender, Chapter 7 of this volume.
25 Hoag, H.J. 2013. *Developing the Rivers of East and West Africa. An Environmental History*. London: Bloomsbury, p. 177.
26 See Morand, Siniba and Fall, Chapter 17 of this volume.
27 See Ertsen, Chapter 9 of this volume.

28 See Cutler, Chapter 8 of this volume.
29 Transport of water in the form of food has been labelled as 'virtual water' by the like of Tony Allan in a number of works, but this concept with its implicit theoretical and political premises is highly context-dependent and not particularly useful in historical analyses.
30 See Dessie, Chapter 20 of this volume.
31 See Beyene and Sandström, Chapter 21 of this volume.
32 See Blouin, Chapter 4 of this volume.
33 See Mikhail, Chapter 6 of this volume.
34 See Haller, Chapter 15 of this volume.
35 See Benjaminsen, Chapter 16 of this volume.
36 See Kolding, van Zwieten and Mosepele, Chapter 18 of this volume.
37 See Reid, Chapter 11 of this volume.
38 See Kampanje-Phiri and Dean Kampanje-Phiri, Chapter 19 of this volume.
39 See Håland, Chapter 2 of this volume.
40 As an example, when the International Food Policy Research institute wrote their *25 Years of Food Policy Research* in 2000, not a word on water was mentioned. Instead the report focused on global food trends, food subsidies, markets under structural adjustments, agricultural linkages to other sectors, biases against agriculture, household food security, environment, agricultural science and technology policy, and trade and globalization (Pinstrup-Andersen 2000). While the role of water to a large extent has been omitted or given at best a secondary significance in the development and constitution of society, today it is incorporated at full strength particularly in policy-based research, but often with an emphasis on the negative aspects or the consequences of climate change or environmental degradation. In the recent decade there has been an explosion of studies on water and food. From 2007–11 the worldwide publication of articles on water resources and food and water grew to almost 5 to 10 per cent annually, and this trend does not seem to stop. In 2011 more than 6,000 articles on water resources and 4,000 articles on water and food research were published (SIWI & Elsevier 2012: 7). A great number of these studies are conducted within the framework of 'Integrated Water Resource Management' (IWRM), but we will argue that a water systems perspective captures the processes at work in a better way without being political normative.

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